



**CE 417 Pavement Design, Construction
and Management
FALL 1999 Midterm Exam**



Read all questions carefully and thoroughly. This is a closed book exam. Show all calculations, label all diagrams completely, and answer all questions concisely for full credit. Neatness counts!!!! No calculators allowed. Start each question on a new page in your exam booklet(s). 1 hour 20 minutes to complete the exam.

- 1) a. Name and describe the physiochemical mechanisms of five asphalt concrete aging processes. **(5 marks)**
b. How does each aging mechanism you described in a) influence the cracking, rutting and stripping performance of asphalt concrete in the field over the life of the pavement? **(5 marks)**
- 2) a. With the help of a gradation chart sketch, show the maximum density line and SHRP's recommended gradation limits for a 19mm nominal mix on a 0.45 power gradation chart **(5 marks)**
b. With the help of a gradation chart sketch, what are the three zones of the gradation chart that are to be avoided (for conventional dense graded mixes) and explain the detrimental effect each zone has on field performance. **(5 marks)**
c. With the help of a gradation chart sketch, what hot mix asphalt concrete gradation does SHRP recommend relative to the maximum density line and why. **(5 marks)**
d. What are the benefits and disadvantages of employing SHRP recommended hot mix asphalt concrete gradation for typical aggregate pits found in glacial till regions. **(5 marks)**
- 3) a. Identify the pavement distress(s) shown in the attached photos. Describe the factors that cause each distress and the propagation mechanisms of each distress. **(5 marks)**
b. Describe the impact on performance each distress will have on a sand versus an expansive clay subgrade. **(5 marks)**
- 4) a. Describe and compare continuously reinforced concrete pavement and jointed reinforced concrete pavement. **(5 marks)**
b. What is the benefit of continuously reinforced concrete pavements over jointed rigid pavements. **(5 marks)**
c. What is the function of a PCC pavement base coarse and what critical base coarse design parameters must you as an engineer ensure during the base construction in order to ensure good field performance of the PCC pavement system. **(5 marks)**



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- 5) In addition to gradation, SHRP specifies seven aggregate properties that are to be controlled for hot mix asphalt concrete. Name five of the seven aggregate properties and describe their influence on field performance. **(10 marks)**
- 6)
 - a. If asphalt concrete is placed with too high air voids, what could be the causes and what are three performance problems that can be expected (explain the specific mechanisms of the detrimental effect on performance)? **(5 marks)**
 - b. If an asphalt concrete is placed with too low air voids, what could be the causes and what are three performance problems that can be expected (explain the specific mechanisms of the detrimental effect on performance)? **(5 marks)**
- 7) What are three types of asphalt concrete mix plants and describe their operational characteristics, and their advantages and disadvantages in typical rural and urban applications. **(10 marks)**
- 8) What are the three primary decision criterion you must consider when evaluating alternative engineering solutions to a given problem. **(5 marks)**
- 9) In the past, road engineers have primarily employed phenomenological-empirical based methods for the design/analysis of roads. The road industry is now moving towards mechanistic based methods. Explain the limitations of conventional empirical-phenomenological methods and explain why there is a need for the road industry to move towards mechanistic based methods. **(10 marks)**



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Photo A



Photo B



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Photo C



Photo D



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Photo E